# COMMONWEALTH OF AUSTRALIA

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### Warning

CHARLES DARWIN UNIVERSITY

| | |
|---|---|
| **Family Name** | |
| **Given Names** | |
| **Student Number** | |
| **Teaching Period** | Semester 2, 2016 |

| **FINAL EXAMINATION** | **DURATION** |
|---|---|
| **SCH102 – Organic and Inorganic Chemistry** | Reading Time: **10** minutes<br>Writing Time: **180** minutes |

## INSTRUCTIONS TO CANDIDATES

The examination has 3 sections

| | |
|---|---|
| Section A: Suggested Time: 60 min | Multiple Choice Questions: Answer all (40) questions<br>Total: 40 marks (1 mark each) |
| Section B: Suggested Time: 60 min | Short Answer Questions(Inorganic Chemistry): Answer all (5) questions<br>Total: 30 marks (6 marks each) |
| Section C:Suggested Time: 60 min | Short Answer Questions(Organic Chemistry): Answer all (5) questions<br>Total: 30 marks (6 marks each) |

**Section A** must be answered on the multiple choice answer sheet provided. **Section B** and **Sections C** must be answered in **two separate answer booklets.**

## EXAM CONDITIONS

**You may begin writing from the commencement of the examination session.** The reading time indicated above is provided as a guide only.

This is a CLOSED BOOK examination

Any calculator is permitted

No handwritten notes are permitted

No dictionaries are permitted

| ADDITIONAL AUTHORISED MATERIALS | EXAMINATION MATERIALS TO BE SUPPLIED |
|---|---|
| none | 2 x 16 Page Book<br>1 x 4-Multiple Choice Answer Sheet<br>Formula Sheet and Periodic table |

# THIS EXAMINATION IS PRINTED DOUBLE-SIDED.

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# Section A
# Multiple Choice Questions

This section should be answered on the **multiple choice booklet** provided. Please ensure that your name and student number is written on the **booklet** and placed in the completed answer Booklet.

1 mark for each question. **Total Marks for this section: 40**

Suggested Time allocation for Section A: **60 minutes**

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## Section B - Inorganic Chemistry
## Short Answer Questions
**Answer all (5) questions. Total Marks for This Section: 30 Marks**

This section should be answered in the Answer Booklet provided.
Marks for each question are indicated. Suggested Time allocation for Section B: **60 minutes**

**Question 1**

(a) Balance the following reaction by half reaction method and clearly show the steps involved.

$$Cr_2O_7^{2-}(aq) + SO_3^{2-}(aq) \rightarrow Cr^{3+}(aq) + SO_4^{2-}(aq)$$

i. Give the oxidation states of all the chemical species

ii. Balance the equation by half reaction method, clearly showing the steps involved

[Marks: 3]

(b) Following is the cathodic reaction in a lead-acid car battery. As current flows, the lead(IV) oxide is reduced to lead(II) sulfate.

$$PbO_2(s) + HSO^-_4(aq) + 3H^+(aq) + 2e^- \rightarrow PbSO_4(s) + 2H_2O(l)$$

If $1.8 \times 10^{-5}$ amperes of current flows continuously for 7 days, what mass of lead(II) sulfate is produced? (molar mass of $PbSO_4$ = 303.26 g/mol)

[Marks: 3]

**Question 2**

Consider the following two half-reactions at 25$^{o}$ C:

$Cr^{3+}(aq) + 3\ e^{-} \rightarrow Cr(s)$ $\quad E° = -0.41$ V

$Sn^{2+}(aq) + 2\ e^{-} \rightarrow Sn(s)$ $\quad E° = -0.14$ V

i. Write the overall balanced reaction in the direction in which it is spontaneous.

ii. Identify and write the cathode and anode half reactions.

iii. Calculate the standard cell potential.

iv. Write the cell notation of the galvanic cell.

v. If $[Cr^{3+}] = 0.15$ M and $[Sn^{2+}] = 0.040$ M, calculate the cell potential at 25°C.

[Marks:6]

**Question 3**

(a) Write balanced chemical equations for the reactions of Mg with:

i. chlorine

ii. nitrogen

[Marks: 2]

(b) Classify the following acids as replacement acid or oxidising acid.

i. dilute hydrochloric acid

ii. dilute nitric acid.

[Marks:1]

(c) Write balanced chemical equations to show the reaction of **Zn** with each of the acid listed above.

[Marks:3]

**Question 4**

(a) Draw **Lewis dot diagrams** to indicate the atoms that donate the electron pair during complex formation.

i. $C_2O_4^{2-}$ (*oxalato)*

ii. $CN^-$ (*cyano)*

[Marks:2]

(b) Consider the coordination compound $Ca_2[Co(CN)_6]$:

i. Give the systematic name of the compound.

ii. What is the magnetic property of the complex (diamagnetic, strong or weakly paramagnetic)? (Use the appropriate d-orbital splitting diagram from the formula sheet to explain your answer)

iii. Will the complex be a high-spin or low-spin complex?

[Marks:4]

**Question 5**

(a) Name an oxyacid of sulfur and its anhydride.

[Marks:1]

(b) Classify each of the following hydrides as saline, molecular or metallic.

i. $MgH_2$
ii. $CH_4$
iii. $H_2S$
iv. $PtH_3$

[Marks:2]

(c) Give two most important uses of ozone.

[Marks:2]

(d) While noble gases are generally considered inert, some noble gases react and form compounds under special conditions. Give an example to substantiate this statement.

[Marks:1]

## Section C - Organic Chemistry
## Short Answer Questions
**Answer all (5) questions. Total Marks for This Section: 30 Marks**

This section should be answered in a separate the Answer Booklet provided (separate booklet to section B).

**Show <u>all</u> formulas and working.**

Marks for each question are indicated. Suggested Time allocation for Section C: **60 minutes**

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**Question 1**

(a) Use an orbital energy level diagram to:

i. explain how electrons fill up the orbitals of a carbon (1s2, 2s2, 2p2) atom

ii. explain how carbon atomic orbitals hybridise to give molecules with the following shapes:

1. tetrahedral
2. linier

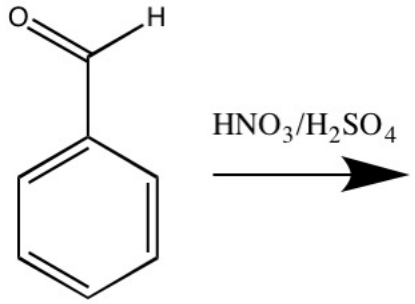
[Marks: 3]

(b) Carbonyl functional groups (>C=O) are extremely useful in organic synthesis due to their ability to change from trigonal planar to tetrahedral geometry. Choose one reaction of the carbonyl functional group where the atoms transition between hybridisation states. Explain the reaction mechanism including giving the hybridisation states of the atoms involved (you do NOT need to draw an orbital energy diagram for this!)

[Marks: 3]

**Question 2**

(a) Draw and name the product that the following reaction would produce:




[Marks: 1]

(b) Explain the mechanism of the reaction from part a.

[Marks: 1]

(c) Using Wheland diagrams, explain the regioselectivity of the reaction from part a.

[Marks: 2]

(d)

i. What is Huckel's rule?

ii. How would you apply Huckel's rule to determine if a compound would be expected to exhibit aromatic properties?

iii. Give one example of a five membered ring that has aromatic properties.

[Marks: 2]

**Question 3**

(a) Draw the saw-horse (or wedge-dash) projection of (2S,3R)-3-methylpentan-2-ol.

[Marks: 1]

(b) Draw the Newman projections of the 2-3 bond in (2S,3R)- 3-methylpentan-2-ol.

[Marks: 2]

(c) Based on the Newman projections from part b. - draw a rotation vs. energy diagram (you do NOT need to give specific energy values in this diagram) that will allow you to identify the most stable confirmation around the 2-3 bond. Assume the greatest steric and torsional strain occurs when the hydroxyl and ethyl groups align.

[Marks: 1]

(d) What kind of reaction would occur if you added a strong acid to (2S,3R)-3-methylpentan-2-ol?

Explain the mechanism of this reaction assuming that the reaction has first order rate kinetics.

[Marks: 2]

**Question 4**

(a) Using R-2-chlorobutane as an example, compare and contrast $S_N1$ and $S_N2$ reactions.

Things you may wish to consider are:

i. stereochemistry

ii. solvent

iii. leaving group

iv. strength of nucleophile

[Marks: 5]

(b) Give one method for separating racemic mixtures.

[Marks: 1]

**Question 5**

(a) Given the following spectroscopic data, identify and draw the compound. Explain your reasoning.

i. MS molecular ion: 102

ii. $^{1}$H NMR peaks

a. 1.15 *t* (3H)

b. 1.25 *t* (3H)

c. 2.35 *q* (2H)

d. 4.15 *q* (2H)

[Marks: 4]

(b) For 1-cyclohexyl-eth-1-ene, sketch and label the:

i. Infrared spectrum

ii. $^{13}$C NMR spectrum

[Marks: 2]

**End of Examination paper**

**FORMULA SHEET:**

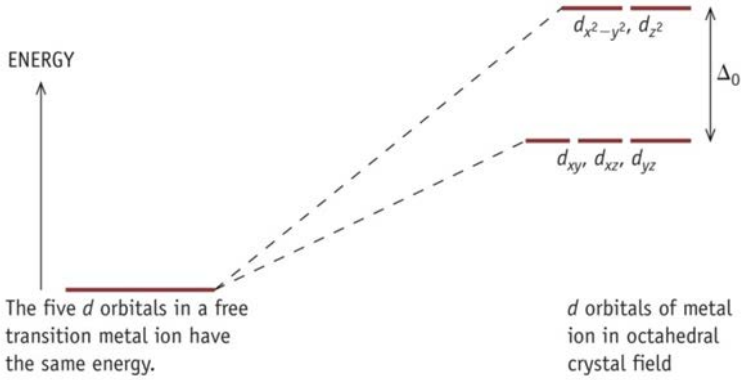
***Some physical constants that might be useful:***

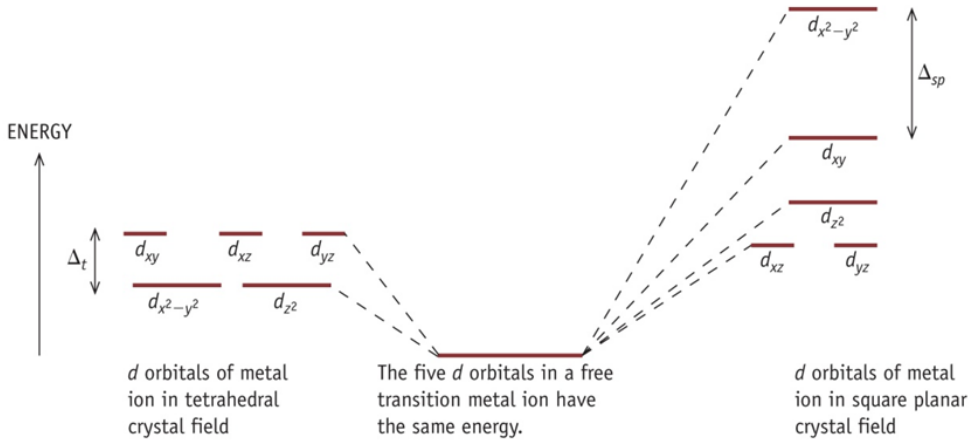
Avogadro's number ($N_A$) = $6.022 \times 10^{23}$
Universal gas constant(R) = 8.314 J/K.mol = 8.314 volt.coulomb/mol.K
1 cal = 4.184 J, Faraday's constant(F) = 96500 coulomb/mol

***Some equations that might be useful***

$$E_{cell} = E°_{cell} - \frac{RT}{nF}\ln Q \qquad Q = \frac{[C]^c[D]^d}{[A]^a[B]^b} \qquad pH = -log[H_3O^+]$$

$$m_{deposited} = \frac{it}{96500}\left(\frac{MM}{n_e}\right)$$

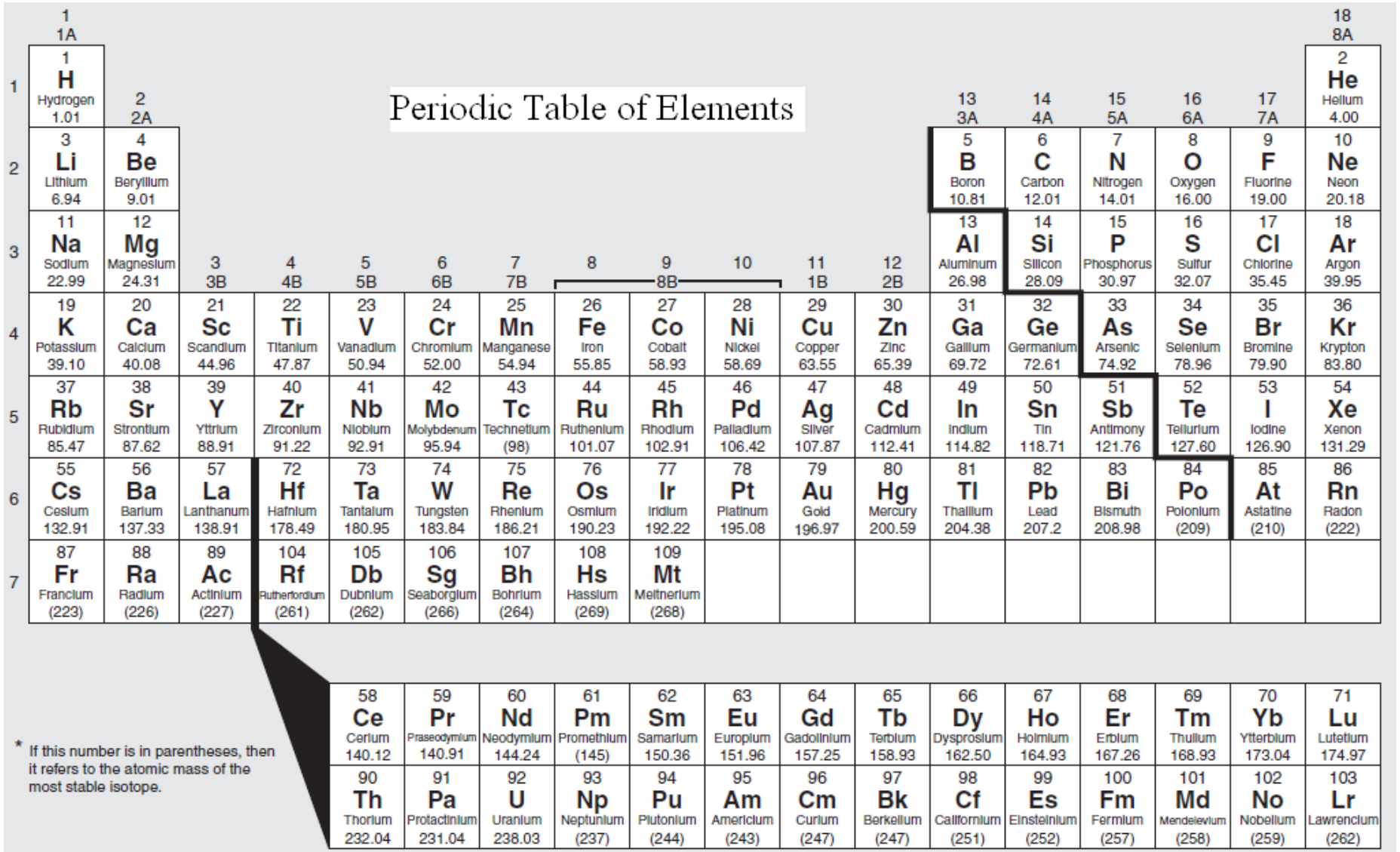



Ligands

$I^- < Br^- < SCN^- < Cl^- < F^- \leq OH^-, ONO^- < OH_2 < NCS^- < NCCH_3 < NH_3, py < NO_2^- < CN^-, NO, CO$

*weak-field ligands* *strong-field ligands*






FINAL EXAMINATION
SCH102 – Organic and Inorganic Chemistry
Semester 2, 2016